STATEMENT OF THE HONORABLE LANGHORNE M. BOND, FEDERAL AVIATION ADMINISTRATOR, BEFORE THE SENATE COMMITTEE ON COMMERCE, SCIENCE AND TRANSPORTATION, SUBCOMMITTEE ON AVIATION, CONCERNING HUMAN FACTORS. AUGUST 25, 1980

Mr. Chairman and Members of the Subcommittee:

I welcome the opportunity to appear before you today to discuss the human factor causes of air carrier accidents. Much attention has been focused recently on the performance of equipment in aviation, while little has been said about the human element which bears the greatest responsibility for aviation accidents.

Before discussing FAA's various programs concerning human factors, I would like to advise the Subcommittee of five major steps we are taking in response to needs we have identified in the human factors area:

o We are issuing a Notice of Proposed Rulemaking which would allow the Administrator of the FAA to request and obtain Flight Data Recorder information and Cockpit Voice Recorder information from air carriers, air taxis, and commercial operators. This information would be used to study the human factors problems associated with aircraft operation and design to determine what, if any, further regulatory changes should be made to enhance aviation safety. Moreover, these on-board recordings offer the opportunity to study systematically such

things as cockpit crew management and workload, pilot/controller interface, and the performance of new airborne systems.

o We are also issuing an NPRM designed to prohibit the performance of duties and activities in the cockpit of air carriers, commercial operators, and air taxis which are unnecessary for the safe operation of the aircraft. These nonessential flight duties, such as using company radio frequencies to order galley supplies, confirm passenger connections, and make hotel and car rental reservations, can create potentially dangerous distractions for the cockpit crew. We believe that the proposed elimination of non-safety related duties and activities would improve cockpit discipline and, thus, assist in reducing the possibility of pilot error.

o We intend also to issue a Notice of Proposed Rulemaking that would allow the FAA to periodically review the type certification basis of aircraft in service, and to require such changes as may be necessary to ensure that aircraft of that type design meet the level of safety current at the time of review. The current regulations lock an aircraft's airworthiness level into the regulations effective at the time its type certificate was applied for, regardless of the number of changes that are made to the aircraft or how old and outdated those regulations

may be. We anticipate that the initial review process will begin approximately eight years after certification, with a determination regarding the adequacy of the aircraft's level of safety being issued by the tenth year. Subsequent reviews would likewise follow this eight to ten year cycle.

o We are also in the process of developing a Notice of Proposed Rule Making that would require Line Oriented Flight Training (LOFT) as part of air carrier simulator recurrent training programs. This rule would require those air carriers with approved flight simulator training programs to include LOFT as an integral part of their recurrent training. LOFT offers the potential for correcting a wide range of human factors problems through simulator training.

o We have scheduled a two day "Human Factors Workshop"in October which will bring together knowledgeable people from government, industry, the military and consumer groups to discuss human factors issues relating to crew workload. The workshop will cover a variety of subjects such as workload measurement techniques in the present and future ATC environment, the safety relationship between crew workload and crew complement, and the application of inflight data for use in human performance studies. It will also explore the question of simulating workload with two or three crew members.

I would like to point out as I have done in my decision on the certification of the DC-9-80 which will be released tomorrow, that each of these initiatives will address the concerns of the Air Line Pilots Association (ALPA) that while the DC-9-80 may be safe today it would be safer in the future with three crew members. The FAA's proposal will cause the data base to be assembled to test the allegations and permit changes in this and other future aircraft should the data base and further human factors analyses prove out ALPA's claims. Let me emphasize, however, that I have found that the DC-9-80 is capable of being flown safely with two crew members.

To strengthen our human factors programs, last year I established the DOT/FAA Task Force on Human Factors in the National Aviation System. The Task Force is under the direction of the Associate Administrator for Aviation Standards, Walt Luffsey. It has been given the broad based assignment to coordinate the FAA's human factors programs and to study the implications of current and future developments in flight operations, air traffic control, and aircraft certification with respect to the potential for human error, and to state the requirements for FAA research and development to ensure that new equipment and procedures are designed to be fully compatible with human limitations. Our emphasis is placed on achieving a

better understanding of the impact of advanced technology on the performance of the controller and the flight crew.

We believe these steps will provide us with short-term benefits to safety, and will provide a good foundation on which to launch further long-term efforts designed to minimize human error in our air transportation system. The relevance of these steps to the promotion of safety will become clear as I progress in my discussion of human factors.

In looking at human factors, we need to recognize that there are two major elements which must be addressed, both as separate elements and as an integrated unit. I am referring to controllers and pilots and the interface between the two groups. Human factors play an important role on the ground as well as in the air, and the safety of our air transportation system hinges upon proper and disciplined performance by controllers and pilots.

Though controller caused accidents have been rare, we have experienced an increased number of system errors in recent years. In the terminal environment, system errors increased from 290 in 1977 to 380 in 1979. In the en route environment, system errors increased from 217 in 1977 to 231 in 1979.

Over ninety percent of those system errors occurred as a result of human error, from causes such as inattention to duty, poor judgment, lack of coordination among controllers, failure to properly identify aircraft and poor communicative skills. Each system error is carefully investigated and the cause identified by a System Error Review Board. If you ask us how, and perhaps even why, a specific system error occurred, we can tell you. If, on the other hand, you ask us why the aggregate increase in system errors, we have no concrete or scientific answer. It is an area of human factors we have looked at but it is apparent to us that much more analysis needs to be done. I assure you if we had a good answer, system errors would be on the wane. The increase in system errors illustrates how important human factors are to the safety of our system, and just how elusive the answers can be.

On the human factors side, there are a variety of things we have done to improve the performance of our controller workforce. We have worked to refine our entry requirements and our training procedures. We have provided simulators at our training academy as well as at our air traffic control facilities so that complex air traffic problems can be worked in an operational environment without safety hazard. We have initiated various programs in our facilities to provide better supervision, and to instill in

our workforce a greater spirit of professionalism. We have sought to introduce more uniformity in the system through greater use of standard operating procedures. We are looking at an optimum air traffic control sector arrangement, both in the context of visibility of display and accessibility of input/output devices. We will be analyzing proposed changes to the data information displayed to controllers on ATC system displays in an attempt to define an optimum format which will permit the most efficient use of display data under heavy traffic conditions. We are working to develop controller performance measures which will support the development of an optimized Electronic Tabular Display Subsystem and to evaluate productivity and performance enhancements achieveable from this system.

We are initiating an effort to examine the potential impact of computer aided reasoning on air traffic control tasks in an automated environment. Two efforts are underway: one through an FAA agreement with the Defense Advanced Research Projects Administration and the Rand Corporation to examine the applications of computer aided decisionmaking; the other, a study being undertaken through an interagency agreement between NASA and the Office of Naval Research to determine and analyze

problems associated with controller acceptance of computer aided decisionmaking.

We also will be undertaking a project intended to demonstrate the feasibility of automating routine en route air traffic control processes. Part of this effort will be an assessment of the capability of such an automated system to enhance controller performance in high workload situations and assure vigilance during routine operations.

In another effort, we intend to determine the impact of aircraft equipped with cockpit displays of traffic information (CDTI) on controller workload, on the optimum balance of responsibility between controller and pilot in a CDTI environment, and to establish the impact of CDTI on the safety, efficiency, and capacity of the air traffic control system.

In short, Mr. Chairman, we are very concerned with the human factors problems affecting controllers. We have already undertaken a number of efforts to better define these problems, and intend to undertake more in an effort to reduce the possibility of human error on the part of our controller workforce. You may be assured that the subject of human factors

will play a major role as we progress in our efforts to define and build the air traffic system for the future.

I would like to turn now to a discussion of human factors as they relate to pilots. Historically, pilot error has been a contributing factor in the majority of aircraft accidents. NTSB data from 1975 to 1978, for example, shows that approximately 66% of air carrier fatal accidents, 79% of commuter fatal accidents, and 88% of general aviation fatal accidents were caused by pilot error. Likewise, pilot error has played a significant role in aviation incidents, which are occurrences that fall short of the seriousness of accidents but are an important indicia of the performance of our system. NTSB findings have confirmed that errors of judgment and poor management by the cockpit crew are a significant factor in a majority of accidents and incidents.

The human factors cause of accidents has long been of concern to the FAA, but has proven one of the most troublesome problems to solve. The need to devote significant attention to this problem was pointed out by a DOT task force in 1975 which stated that the "FAA must undertake a major safety research program to assure that future aircraft designs make optimum use of crew capabilities, and to ensure that future systems are designed

around reasonable criteria for human error." In partial response to this recommendation, the FAA's Office of Systems Engineering Management (OSEM) undertook an in-house study to identify those human factors problems associated with air carrier and general aviation accidents and incidents. As part of this program, the FAA solicited the comments of both industry and government groups. The results of that study and the feedback received from the various groups were then used to formulate a program of human factors research aimed at reducing pilot error.

Based on our review of air carrier accidents and incidents, we believe that the most significant human factors problems include: Air Traffic Control Interface; Flight Deck Management Failure; Fatigue; Crew Workload; Behavioral Problems; Aircraft Design; and Medical and Toxicological Problems. Let me touch briefly on each.

Air Traffic Control Interface--problems in the interaction of the flight crew with the air traffic control system--can be a contributing factor in aircraft accidents. Possibilities for such problems must be thoroughly evaluated with respect to new systems. Systems such as the Discrete Address Beacon System (DABS) data link for the automatic transfer of data allow for a

more efficient means of transferring data between pilot and controller, but must be studied to assure that they have no negative human factors effects. Systems like Cockpit Display of Traffic Information (CDTI) and other airborne systems may have workload and coordination effects on both the cockpit crew and controller that must be understood before implementation.

Flight Deck Management Failures including inadequate discipline, poor crew coordination, and failure to follow required procedures present another significant human factors problem. These problems, which have resulted in several accidents in recent years, occur for two general reasons: motivational failure and managerial failure.

Motivational failures occur when the flightcrew willfully fails to perform a function properly; for example, requesting to land on a shorter crosswind runway to minimize taxi time, continuing descent after a Ground Proximity Warning System alert, or discussing non-pertinent subjects during a critical phase of flight. Managerial failures, in contrast, result from an unintentional deficiency in judgment, training or inadequate procedures. Managerial failures have occurred, for example, when a captain failed to clearly delegate responsibility for flying the aircraft to the first officer after problems

occurred with the landing gear which required him to devote his full attention to trouble shooting of the electrical system, and from the failure of the first officer to point out emphatically to the captain that a critically low fuel status required an expedited landing.

The legislative authority we have requested recently to increase the dollar amount of civil penalties that can be assessed by the FAA for regulatory violations would provide a stiff deterrent to willful motivational failures.

Fatigue as a factor in the cause of aircraft accidents can be defined as the "detrimental alteration or decrease in skilled performance related to duration or repetitive use of that skill, aggravated by physical, physiological, and psychic stress." Air safety investigators generally agree that many erroneous decisions and inappropriate or delayed actions associated with aircraft accidents may be attributable to fatigue. But, there is no test or index for the quantitative measurement of fatigue in an individual pilot or controller.

FAA and industry efforts to decrease fatigue-inducing physical and environmental factors associated with flying such as noise, vibration, and hypoxia have contributed greatly to air safety.

In addition, we are working to understand better the influence of psychological stress on fatigue-related accidents. Though psychological stress is not readily quantifiable, it has been shown to be closely related to human performance.

To deal further with the subject of crew member fatigue, we recently issued a supplemental NPRM that takes into account the duty time that crew members put in--that is, the time from when they report to work until they go off duty--along with actual hours of flying. This proposed change recognizes that time spent preparing for flight and waiting between flights can add to crew fatigue.

Crew Workload is also a factor which can affect safety. Safety may be affected by workload being too low as well as too high. Excessively low workloads may cause a degradation in cockpit discipline which has a negative effect on safety. Similarly, excessively high workloads can have a negative effect on safety, by causing confusion and allowing inadequate time to monitor critical systems or to perform critical tasks. We are, therefore, continuing to study crew workload with emphasis placed on the workload effects of airborne automation systems, new technology instrument displays, division of responsibility between crew members, and division of responsibility between the flight crew and the air traffic controller.

Behavioral factors are perhaps the least well understood of the major problem areas. These factors range from minor problems such as interpersonal conflict between crew members, to temporary stress resulting from family difficulties, to debilitating mental illness. The entire spectrum of behavioral problems can cause or contribute to aircraft accidents. I would point out, though, that it is only in the most clearly defined cases that accident investigators can conscientiously attribute the cause of the accident to behavioral factors.

Behavioral problems associated with aircraft accidents may go undetected because pilots and controllers tend to conceal these facts from investigators for various reasons including potential legal liability and feelings of guilt. Moreover, the civil investigating authorities have in the past generally lacked the sophisticated mental health expertise needed to evaluate the evidence of behavioral problems if uncovered.

Aircraft Design improvements have the potential for reducing pilot error. It is well established that the application of state-of-the art human factors design engineering including an increased level of standardization in flight deck equipment, such as standardized computer keyboards and symbolic representations on cathode ray tube flight displays, can

decrease the probability of human errors. This has been documented in numerous reports by the U.S. military, by past studies of the NTSB, and in recent FAA reports on cockpit standardization. Our research is continuing with respect to conventional flight deck instruments as well as advanced display techniques.

Medical problems may be subtle, acute or chronic. Acute conditions such as heart attacks, strokes, or seizures can lead to complete or partial incapacitation of a pilot or controller. Chronic diseases can also be incapacitating, having a deleterious effect on both flight crew and controller performance. FAA's medical certification process seeks to identify medical problems in flight crew members and controllers and deny certification to those individuals determined to be unsafe. We also do our best to keep abreast of advances in medical science with a view towards incorporating in our medical certification program those elements which will enhance safety.

Toxicological factors may result in decreased performance, of a crew member, leading to an accident. Toxins affecting performance can come from numerous sources, including cargo aboard the aircraft, toxic gases from combustion, or from

alcohol or drugs consumed by the pilot or controller. These factors are monitored in the Aviation Toxicology Laboratory at our Civil Aeromedical Institute in Oklahoma City, where toxicological assessments are conducted in about 65% of the accidents in which pilots are killed. Over the years, these studies have resulted in an effort to educate the civilian aviation community regarding dangers associated with exposure to toxins. We intend to continue our pilot education program regarding toxins and air safety, as well as our toxicological studies of pilots killed in accidents.

In 1978, our Engineering and Development organization undertook concentrated efforts in an Aircrew Performance Enhancement and Error Reduction Program and a counterpart program, the Controller Performance Enhancement and Error Reduction Program. We are also working in close partnership on human factors studies with the National Aeronautics and Space Administration and the Department of Defense.

These activities will utilize cockpit simulation facilities which are located at our own Technical Center, at the NASA Ames Research Center, and the NASA Langley Research Center, as well as air traffic control simulation facilities located at our Technical Center. These facilities will help us perform

analyses involving both pilots and controllers to examine existing and future airborne and ground systems. We are strengthening our human factors capability and facilities at the Technical Center to permit a concerted attack on these problems. A variety of different activities are being undertaken, including an evaluation of head-up display, an analytical study of future cockpit information requirements, an aircraft alerting system standardization study, a runway/taxiway transgressions study, and an analysis of pilot workload measures.

These engineering and development programs should provide us with greater insight concerning human factors and enable us to modify various elements of our system to reduce the possibility for human error.

We intend to continue the assessment of crew member workload as an integral part of new aircraft certification by utilizing not only proven techniques but by developing and evaluating a new technological base to assess cockpit crew workload. As cockpit automation is employed and new technology systems are utilized, we are continuing to upgrade our crew workload and crew complement analyses to ensure safe crew complement and level of workload. This requires an analysis of the workload/safety

relationship, taking into consideration such things as division of duties in the cockpit, division of responsibilities between the flight crew and the controller, effect of command responsibility, and the effects of increased cockpit automation.

We will also be analyzing those physiological factors such as: self-imposed stress; commuting time to duty station; dietary effects; use of tobacco, alcohol, and drugs (both illicit and prescribed) which may be contributing factors in aircraft accidents.

With the introduction of new flight system concepts, we have found it necessary to evaluate air traffic and flight operational scenarios to determine the workload impact and coordination between the flight crew and the air traffic controller. This analysis will be especially useful in assessing the effectiveness of data links.

Our air traffic control system automation project has as a major element research to determine the best utilization of the human controller in an automated air traffic control system.

The Subcommittee is well aware of the use of simulators today in assessing pilot performance. The role of simulation has

been further enhanced by the Advanced Simulation regulation which went into effect on July 30. The sophistication and realistic nature of advanced simulators now available provides us a great opportunity for pilots to perform manuevers which could be hazardous in flight, but which are extremely beneficial in developing the capability to deal with inflight emergencies. Moreover, simulators provide the opportunity to introduce windshear and other elements into the training scenario which would not otherwise be possible. The use of Advanced Simulators integrated with line oriented flight training programs can provide a significant improvement in crew coordination training and can also be used to correct other human factors problems. I have with me today an FAA expert on flight training simulators who can provide substantially greater insight to the Subcommittee on the present and possible uses of simulators in advancing pilot skills.

Mr. Chairman, that completes my prepared statement. My associates and I would be pleased to respond to questions you may have.